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POLAR ICE

Die Metamorphosen des Polareises. Von Karl Weyprecht. (Wien, 1879: Moritz Perles.)

THIS book of Karl Weyprecht's is a most valuable outcome of the Austro-Hungarian Arctic expedition of 1872–1874, so well known already from the interesting general popular account of the doings of the expedition which has been published in most European languages. In the present work the author confines himself to an account of the phenomena presented by the ice amongst which he spent so many weary months. It might well be supposed that a book treating of such a subject only would be dull reading, but so graphic are Lieut. Weyprecht's descriptions, and so pleasantly are his long series of observations strung together into a continuous whole, that his book is most entertaining throughout, and the reader lays it down with a very much enhanced comprehension of the never-ceasing changes and mighty power of Arctic ice. Most of the facts recorded are known to Arctic explorers, and have been more or less set forth by them in their various writings, but no connected account of all the forms of the growth and death, of the movements and struggles of bergs and floes and ice of all forms has been before attempted Lieut. Weyprecht tells it us all from his own observations. The book is divided into a series of chapters headed as follows:—I. Various Forms of the Ice and their Origin. II. Ice-pressures. III. The Ice in Winter. IV. The Ice in Summer. V. The Changes of the Ice. VI. The Water Movement in the Polar Regions. VII. The Ice Movements. VIII. The Ice of the Arctic Interior.

In the first chapter he treats of the three different kinds of Polar ice: glacier ice, salt-water ice, and fresh-water ice. As an example of the mighty size of the Polar glaciers, the parents of the icebergs, he cites the Humboldt glacier of Smith Sound, which, pushing itself into the sea in Smith Sound, forms an unbroken ice coast-line composed of perpendicular cliffs 300 feet in height above the sea-level, and 60 miles in length, a single solid ice wall split only by vertical fissures. The fresh-water ice is clear as crystal, and so hard that the Norwegian walrus-hunters who run their small vessels in their voyages against all other ice obstacles, of whatever size, are careful not to charge even comparatively small pieces of this. This kind of ice is, however, scarce in the polar regions; it is the third kind of ice, that of salt water, or "field-ice," which forms by far the greater part of floating ice, and with which the book is mainly concerned. The *Tegetthoff* was shut in for a year in field-ice, and the author watched the incessant changes in the ice with great care throughout this period.

A simple smooth sheet of sea-water ice is no sooner formed than it begins to be subjected to a variety of influences, which speedily convert its smooth expanse into a complicated rugged surface, covered with ridges, valleys, and irregularities of all kinds, render its thickness everywhere unlike, and split it up with innumerable fissures. Most important amongst the causes of these changes are the variations of temperature to which the ice is exposed from the variation of that of the water below and the air above, and which are more or less local, and affect the ice differently wherever its thickness varies. From these differences of temperature ensue complicated strains in all directions, due to the unequal expansion and contraction of the mass, and the ice is rent by the tension; to these forces is added the pressure of surrounding ice-fields, driven by the action of winds or currents; long fissures are formed, the edges of which grind together with mighty force. After a while the edges separate, and the water between pulsates with the throbbing of the surrounding floes. Again they come together, and forced against one another with ever-increasing power, they are crushed and break up, huge blocks are piled above on the ice-surface, resting at all angles upon one another, and other huge blocks are forced under the ice below. Hence the ice becomes rugged above, and by the freezing to it of the blocks forced under water, equally so below, the variation in thickness is increased, and with it the amount of strains caused by variation of temperature. The drifting snow hangs against the ridges and pinnacles on the surface, and forms banks and mounds which not only increase the effects due to temperature by protecting the areas on which they lie from change, but also by their immense weight, combined with that of the projecting ice-masses by which they are formed, press down the ice which supports them, whilst the blocks below in other regions press it up. Throughout the mass gravity acts as a disturbant, no part being water-borne at its natural level, the mass is strained, and gives way in all directions, and fresh complications ensue.

All these changes are accompanied by a noise. The unlucky prisoner in the field-ice during the imposing unbroken loneliness of the long Arctic night, when the wind is calm, can hear the crackle of the snow under the stealthy tread of the Polar bear at an astonishing distance, and hear what a man, speaking loud, says at 1,000 metres distance. It can, therefore, be well understood how the sound of the ice-pressures must travel to his ear from enormous distances. "Sometimes," the author writes, "the noise of the ice movements was scarcely to be heard —a mere murmur—and came to our ears as does the play of the waves on a steep coast from the far far distance. Sometimes it hummed and roared closer to us, as if a whole column of heavily laden waggons were being drawn over the uneven ice surface." In the sound were combined all manner of noises caused by cracking, grinding, falling of blocks, crushing, and many other phenomena of ice-life. "It is astonishing how far and how clearly every noise is conducted in the ice. The noise at the very margin of the field on which we were seemed to occur immediately at our feet. . . . If we placed our ears to the ice the sound was heard so loudly that we might have expected the ice to open under our feet the next moment. The whole dry ice covering was as a vast sounding-board. Whenever, as I lay down to sleep, I placed my ear against the dry wooden ship's side, I heard a humming and buzzing which was nothing else but the sum of all the noises which occurred in the ice at great distance from the ship."

A curious fact is described by the author, that the surface of an expanse of young salt-water ice on which no snow has yet fallen is soft, so that the footstep is impressed upon its white covering as in melting snow. This is to be

observed even at a temperature of −40° C. The unfrozen fluid is not water, but a concentrated solution of salt thrown out by the freezing of the ice beneath.

When summer begins, the thawing that occurs is very local and unequal. Any dark body, such as a heap of ashes or the droppings of bears, eats its way into the snow, absorbing the rays of heat which are reflected off again by the general white surface. The bear droppings eat their way into the snow, and then into the ice, and the conical hole thus formed fills itself with water. It may, at last, eat its way right through the ice where not very thick. Thus are formed the greater part of those holes in drift-ice which are usually ascribed to seals. The author never saw a seal's hole in winter.

A number of interesting experiments were made on ice phenomena. For example, on March 5, a cube of ice was sunk under the ice-field to a depth of five metres. After a lapse of twenty-four hours it was found that a crust of new ice had formed itself over it about 1 cm. thick. This was caused by the low temperature of the block itself and, from a similar cause, ice-crystals had formed between the edges of the hole, owing to the coldness of its walls. On March 10 very little increase in the added layer of ice on the cube was to be observed. On March 20 this newly-formed ice was found to be softened so that it was easily impressed by the finger; by April 2 it had become harder again, though porous and apparently a little increased. From thence onwards the block dwindled regularly, especially on that part of its surface which was turned upwards; on July 18 it was only a third of its original size; nevertheless, the hole through which it was sunk had, during the last period, become entirely closed by young ice at its lower margin. This experiment shows the loss of ice from below by the action of the warmth of the water. The author concludes from his experiments and measurements that compact salt-water ice can never attain a greater thickness than 10 metres.

Icebergs are subjected to disintegration after somewhat the same manner as rocks so commonly are. They are full of crevasses, into which the water formed by melting penetrates; in winter this water freezes, and by its expansion all through the glacier a rupture of the mass ensues. "It is highly probable that most of the icebergs afloat in winter are in such a condition that a very slight cause is sufficient to make them burst because of their state of internal tension. . . . Every polar traveller can tell how a shot, the driving-in of an ice-anchor, or any other sudden vibration, has brought about the catastrophe; cases have even occurred in which the sound of the voice alone was sufficient. An iceberg is always an unpleasant neighbour." So many are the causes which tend to destroy icebergs that the author concludes "no berg exists which could withstand them more than ten years, and that commonly the life of a berg is much shorter." However this may be, doubtless the much larger Antarctic bergs last very much longer, as must necessarily occur because of the much greater uniformity of the climate to which they are exposed.

With regard to glaciers, the author quotes an interesting observation of Kane's to the effect that even in lat. 78° 20′ during the entire winter, however low be the temperature, the glacier streams never dry up. The melting which supplies them with water can only derive its requisite heat from the friction of the ice-masses.

The chapter on the ice-movements is full of interest. Every field acted on by winds and currents has its own peculiar velocity, depending on the dimensions of the irregularities above and those of the resistances below, in which no two fields are alike. From these differences of velocity arise the irresistible pressures between contiguous fields. The iceberg deeply sunk drifts but slowly, whilst the ice field may travel very fast. If the field catches up a berg in its course, it is broken and torn by the berg; and as it proceeds on its course its broken fragments are piled up block upon block on the coast of the iceberg. To a casual observer it appears as if the iceberg, driven by a counter current below, were being forced in the opposite direction to the ice-field, so as to plough it up. Many groundless accounts of the existence of such counter currents thus observed have been circulated.

Another cause of pressure between ice-fields is that, owing to the irregularities on their surfaces, they are twisted round by the action of the wind, which takes hold more on some regions than others. Every field is differently thus acted upon for each direction of the wind. A similar effect is caused by the currents beneath acting upon the irregularities of the under surface. So various are the movements in the ice-fields, that even when the ice lies all the while closed, it is very seldom that any two pieces remain for any length of time in the same position alongside one another. Two ships beset together by the ice are sure sooner or later to be separated.

The author fully admits that the danger incurred by explorers in the Antarctic regions is very much greater than that to which Arctic voyagers are exposed. The fog in the south is a terrible enemy, and there a ship cannot at once take refuge in the field-ice as in the north. He urges, however, the necessity for scientific Antarctic exploration and observation, and suggests that a wintering in the lands lying south of Cape Horn could be easily accomplished, and would not require any very extensive appliances. We fully agree as to the benefit to be derived by science from a round of meteorological observations and all other kinds of scientific exploration in the Antarctic regions, and heartily wish that such enterprise would take the place of the constant struggles to get to the North Pole. By the mere reaching of the pole there is nothing to be attained. A steamship could very possibly run down from New Zealand direct to Mount Erebus and Terror in a fortnight during the summer months; such an attempt has never been made. It need not be very costly, and possibly the Government of one of the Australian colonies may make it some day. We commend Karl Weyprecht's book to all who study ice phenomena, but not only to specialists, for it is full of interest to all intelligent readers. H. N. MOSELEY

THE SILK GOODS OF AMERICA

The Silk Goods of America. By Wm. C. Wyckoff. (New York: Van Nostrand.)

THIS book has been issued under the auspices of the Silk Association of America, with the view of affording information as to the character of the silk goods manufactured in that country. Not many years since